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Current and Future Research Themes in Forest Sector Competitiveness: Case Study of Research Orientations at the University of Helsinki

BIOPRODUCTS BUSINESS

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Abstract

Megaforces such as climate change, and market dynamics are impacting the development of product and service markets in the forest sector, driving renewal and reorientation. The University of Helsinki (UofH) has produced leading academic research, through global collaborations, on managing that transition by firms within the Nordic forest sector. To further understanding of how much and in what ways their research is aligned to forest sector developments, a case study was conducted assessing (1) the Nordic industrial forest context, (2) the corresponding research contributions and collaborations from 2014–2019, and (3) future research orientations. A conceptual lens of forest-value chain sustainability from the perspective of industrial competitiveness was applied. Research design included three questions for the aspects noted, investigated sequentially to triangulate and validate results. The results highlighted similarities and divergences between current and future research orientations and between researcher perspectives and the actions of incumbent forestry firms. Together, these indicate gaps in the ambition level required to support renewal in industrial competitiveness. Closing them will require a radical transformation, relying on proactive management and investment toward new product and service development, in order for forest industry firms to become champions in the circular and bioeconomy paradigms.

Keywords: Literature review, sustainability transition, bioeconomy, Finland, industrial competitiveness, forest sector

1. Introduction

The concepts of both the circular and bioeconomy, as research paradigms and industrial strategies, imply economic growth-based transformation and development with varied approaches toward achieving sustainability (D'Amato et al. 2017). The concept of "bioeconomy" is more closely associated with business-as-usual operations for the Nordic forest sector and is less reflective of expected transformations in society and the economy, e.g., to meet the 2030 Sustainable Development Goals and the 2015 Paris Agreement on climate change, than circular economy (D'Amato et al. 2017, Guerrero & Hansen 2018, Stern et al. 2018, Hurmekoski et al. 2018). As such, the bioeconomy emphasizes reliance on bio-based resources without linking to upstream or more inclusive innovation.

To an extent, the Nordic forestry sector has reflected both concepts recently via attempts to mobilize bio-based resources with greater efficiency and drive product and service innovation. Nordic firms use wood-based inputs across a breadth of product categories, including, e.g., bio-based textiles, wood products and furniture, liquid biofuels, paper, bio-based chemicals, and bio-based electricity. However, efforts toward higher value-added products have seen mixed results, with a risk of further decline in gross value-added production, contradicting bioeconomy aspirations (Hurmekoski et al. 2018). This is a concern, especially if growing demand is disproportionately allocated to lower value-added products (e.g., pulp) (Pöyry Inc. 2015).

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Key drivers for a recent rise in Nordic bioeconomy investments are the growing global demand for such lower value-added products, e.g., pulp, sawtimber and renewable energy, as well as to address the higher factor costs in comparison to emerging market producers (e.g., Uruguay). Such investments increase the importance of securing resource supply and ensuring sustainability throughout the value chain. This article examines these strategic transformation efforts from the perspective of *industrial competitiveness* – defined here as the o*verall value-creation potential of the forest sector within the circular and bioeconomy paradigms, triggering changes in products, services, processes and networks*.

An examination of the state of the art in circular and bioeconomy forest value chains at country or regional levels in the Nordic context was conducted to start – an approach with limited research to date (see, e.g. Wreford et al. 2019). Thereafter, we examined the state of the art in local academic research orientations: their alignment and/or divergence in perception from the sector's current transition ambition. This is a novel approach for examining transition pathways, their potentials and challenges, relying on research paradigms and qualitative analysis rather than quantitative metrics, e.g., Paris Agreement alignment of greenhouse gas emissions trajectories for corporations.

Among the highest geographical concentration of forests in Europe, Finland is at the center of a regional industrial cluster with head offices for 3 of the 10 largest European forestry, pulp and paper firms (by net income in 2018 terms) (PwC 2016).[1] The strategic push by Finland towards circular and bioeconomy development follows a period of national economic stagnation linked with the structural changes in the global forest product markets with a trend away from paper use (Bouwman et al. 2014), where most forest sector firms have sought higher value-added innovations to replace the revenue losses from declining markets and high costs. Competitiveness and sustainability are at the core of Finnish, Nordic and European efforts to support renewal and innovation in the industrial forestry sector (TEM 2014; European Commission 2012, 2018a,b).

To support implementation of the Finnish Bioeconomy Strategy, the Academy of Finland published an R&D report on future research paradigms to map the national role in the global bioeconomy (Academy of Finland 2014; see Appendix A).[2] Key research orientations in the report focused on networks, value co-creation and innovation, values and perceptions of consumers and individuals, supply of raw material in a sustainable manner, innovation and resource efficiency and the need for new pathways to ensure both adaptation and adaptability. These were later funded in a 10 million euro (MEUR) national research programme (BioFuture 2025, 2017-2020), in short, to support enhanced sustainability and industrial competitiveness in Finland through circular bioeconomic research.

The University of Helsinki (UofH) was a major recipient of those funds. It has been at the forefront of academic research on how industrial forest-sector firms are managing the aforementioned transition and its challenges. To further understand how much and in what ways that research fit within the theoretical underpinnings of the ongoing Nordic industrial forest-based transformation, a case study review was conducted concentrating on UofH's research contributions and collaborations during 2014–2019.[3] Three research questions (RQs) were posed in this study to sequentially gather results (Figure 1), iteratively reviewing and validating new results against earlier results, using them toward further research design in subsequent RQs, and eventually bringing them together in a set of final results and discussion themes (see Section 4). An appropriate research method was selected to investigate each RQ, examining how UofH's research has approached the topic from different geographic, political, economic and social contexts. This review's results are highly topical, given the national and regional importance of the sector for Finland and the Nordics in the transition to a sustainable low-carbon economy.

RQ1 set the foundation, including the theoretical setting on industrial competitiveness and a review of current forest sector market dynamics in the Nordic context (i.e., "market review"). Data included statistical

1 The Finnish bioeconomy contributed EUR 193.3 billion to the national economy (12% of total value added) in 2017, growing by approximately 20% between 2010-2017 (LUKE, 2019). Total value added in the Finnish bioeconomy has increased over time, though the effect on employment has been neutral or negative (Ronzon et al. 2015, Piotrowski et al. 2019).

2 The Academy of Finland (2014) report acts as a reference in this review for assessing new and interesting research findings on forest sector competitiveness in the Finnish geographical and industrial settings during the period of this review (2014–2019).

3 The UofH has been ranked as one of the globally top 5 university level forestry faculties, and has a long history of academic research focused specifically on forest sector competitiveness (Jeglum & Scarratt 1989, CWUR 2017, CWTS 2018). On that basis, it provides a benchmarking case study for assessing academic research developments towards the creation of sustainable competitiveness within the forest sector and its associated transition.

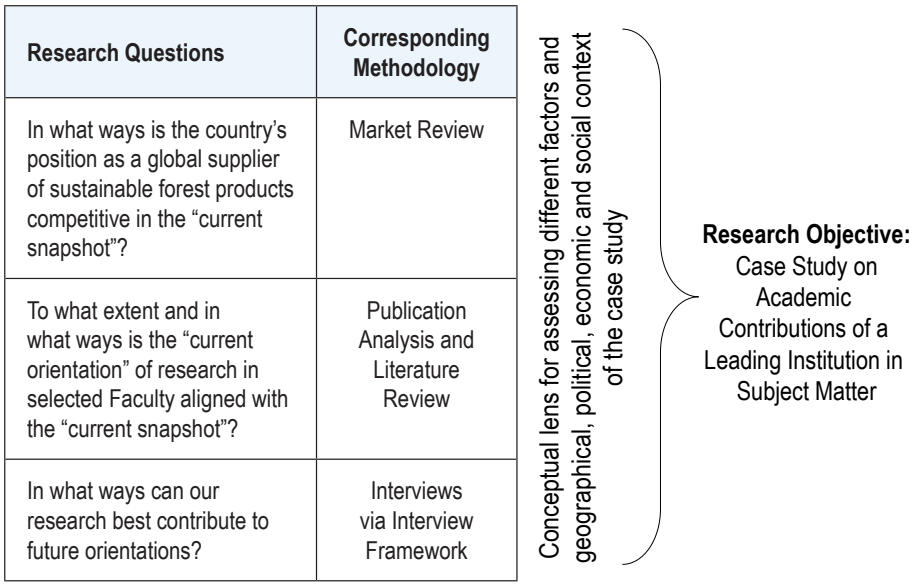

Figure 1. Overview of research questions and corresponding methodologies applied to answer via the case study conception lens (Figure 2). Source: Authors.

and disclosed information on market developments (e.g., firm investments). RQ1 results provided the conceptual lens for comparing and contrasting, triangulating and validating results from RQ2 and 3. For RQ2, a publication analysis and in-depth literature review was conducted, eventually focusing on the 20 highest-profile articles on industrial competitiveness during 2014–2019. RQ3 used expert interviews with 10 faculty members, together with the literature review, to determine thematic alignment or divergences on ambition in the forest sector transformation.

In the next section, we present the theoretical background on industrial competitiveness in the Finnish industrial forest sector based on the outcomes of RQ1. Thereafter, an overview of methods and data used this case study, focusing on RQs 2 and 3, is provided in Section 3, supplemented with further description in Appendix B. In Section 4, results from the publication analysis and four themes based on the results for RQs 2 and 3 are presented and discussed. Conclusions are presented in Section 5, followed by Limitations in Section 6.

2. Theoretical Setting

Toppinen et al. (2017a) provide a framework for the analysis outlining the competitiveness orientations of the Finnish industrial forest sector (Figure 2), which is used in defining "competitiveness" beyond the common concurrent competitiveness measures, such as profitability or market share, and emphasizing the importance of securing future value creation potential (Korhonen et al. 2018a). Sustainable value creation potential is built on the ability to manage internal (i.e., firm resources) and external (i.e., voluntary norms and stakeholders) factors that are linked with global sustainability megatrends, as well as the policy environment and other considerations driving or impacting the emerging range of commercialized forest products and services. As internal factors may be partly controlled by the firm, external factors (e.g., unpredictability of climate change) take an increasingly important role in shaping organizational decisions and actions by the firm (Toppinen et al. 2019).

Key factors in securing sustainable value creation potential can be approached from two complementary theoretical logics. A resource-based view of the firm (RBV) focuses on those characteristics of resources and the strategic factor markets from which they are obtained to explain firm heterogeneity and sustainable advantage (Wernerfelt 1984, Barney 1991, Lopez-Gamero & Molina-Azorín 2016). It considers that resources that are valuable, scarce, inimitable, and non-substitutable (VRIN) provide enduring firm differentiation and above-normal profits and may be viewed as important in the context of proactive environmental management by the firm. The dynamic capability view (Teece et al. 1997) emerged in the 1990s extended the RBV argument by addressing how the VRIN resources can be created and how the

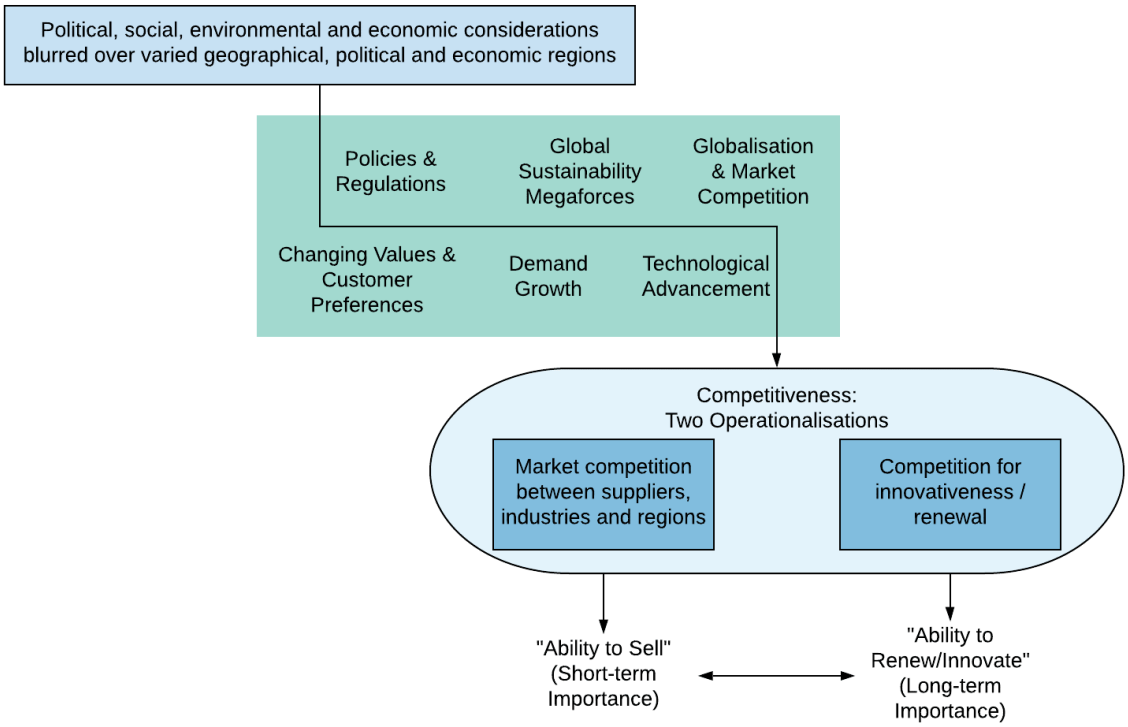

Figure 2. European forest bioeconomic industrial competitiveness – A conceptual lens and guide for this study. Source: Adapted from Toppinen et al. (2017a).

current stock of valuable resources can be refreshed in the changing business environments (for a reference in the wood industry, see Korhonen & Niemelä 2005).

Alternatively, institutional theory considers that rules, norms, and beliefs are part of the context where economic activity occurs and that define or enforce behavior viewed as socially acceptable (Meyer & Rowan 1977, DiMaggio & Powell 1983, Lopez-Gamero & Molina-Azorín 2016). For firms, the theory can be linked to organizational culture, and at the interfirm level, it refers to public or regulatory pressures or norms in a specific industry. Both the resource-based view and institutional theory can be applied to managing the diversifying internal and external expectations that are deriving from the changing operational environment of firms and industries (Yang & Konrad 2011). The resource-based view focuses on the value creating assets and competencies of a firm, while institutional theory considers the firm's capability to support those same assets and competencies. Therefore, external factors create the context where resource strategies and decisions occur.

Toppinen et al. (2017a) provide a summary of the internal and external competitiveness factors important for achieving or maintaining accepted level of sustainability in the context of the bulk and export-driven industrial forestry model of the Nordic region, including, e.g., good governance of natural resources, solid land tenure system, and global societal demand for sustainability. According to those authors, innovation, thus, requires a view beyond costs toward high-value-added products and services.

To explore the competitiveness orientations of the Finnish industrial forest sector, the two theoretical logics are applied, while accounting for the "megaforces" driving a transformation toward sustainability and higher value-added products and services. Mitigating climate change and the negative impacts of other external megaforces increasingly requires a radical sustainability transformation, as part of a broader forest sectoral renewal. This means pursuing diverse and multiple dynamic and adaptive pathways, including for resource limitations, information flows, and network expansion, to provide strategic insights and create resilience (Haasnoot et al. 2013).

In that context, a "mature" industry, such as the Finnish industrial forest sector, should strive to mobilize scarce resources toward new radical product and service niches by avoiding inward-looking and insular networks. The latter can lead to myopic attitudes and potential tech-

nological and capability lock-ins (or lock-outs), limiting transformability of the sector over a relatively short timescale (Geels 2014, Oinas & Lagendijk 2017). As such, it is important to reduce cognitive proximity between firms, which can limit the flow of new knowledge into and its transmission within a network, limiting the potential for renewal (Boschma 2015). Research plays an important role in such networks, if it is able to support knowledge co-production and transfer that support to value proposition development (Korhonen et al. 2018b, Lovrić et al. 2020).

3. Methods and Data

As outlined in Section 1, case study research design centered on three sequential RQs. They were selected through emails and meetings with a panel of experts (hereafter, the "Expert Review Panel") and the co-authors during an initial research design phase (Figure 3, points a-d). In the following data collection phase, results from answering each RQ informed the research design of the subsequent RQs. For example, the market review results for RQ1 informed keyword selection for answering RQ2, and the literature and market review results from RQs 1 and 2 informed the interview framework for RQ3 (Figure 3, points e-h, Appendix B). The results from RQ1 and 2 set the state of the art for Nordic industrial competitiveness and research on it, respectively. Results for RQ3 set out the future research orientations, which together with results for RQ2 informed on how much and in what ways the studied research is aligned to forest sector developments. A triangulation and validation phase resulted in a set of final themes building on outcomes from RQs 2 and 3.

The market review for RQ1 was conducted as outlined in Section 1 and is not described here further; the results were integrated into this article in the Introduction and Theoretical Setting (i.e., case study background). The research procedure for RQ2, publication analysis and literature review, is described further in Section 3.1 and the outcomes discussed in Section 4. The aim of the publication analysis was to depict key concepts and their prevalence in competitiveness research, and the aim of the literature review was to analyse the contribution of 20 key articles fulfilling the predetermined criteria (i.e., research state of the art). The aim of the interviews for RQ3 was to compare and contrast with outcomes from RQs 1 (market developments) and 2 (past research), and set out future research orientations on the case study topic. For further explanation of the methods, see Appendix B.

The research design and approach used in this case study was considered appropriate and reliable, as it supported saturation toward key themes as presented in Section 4, for example:

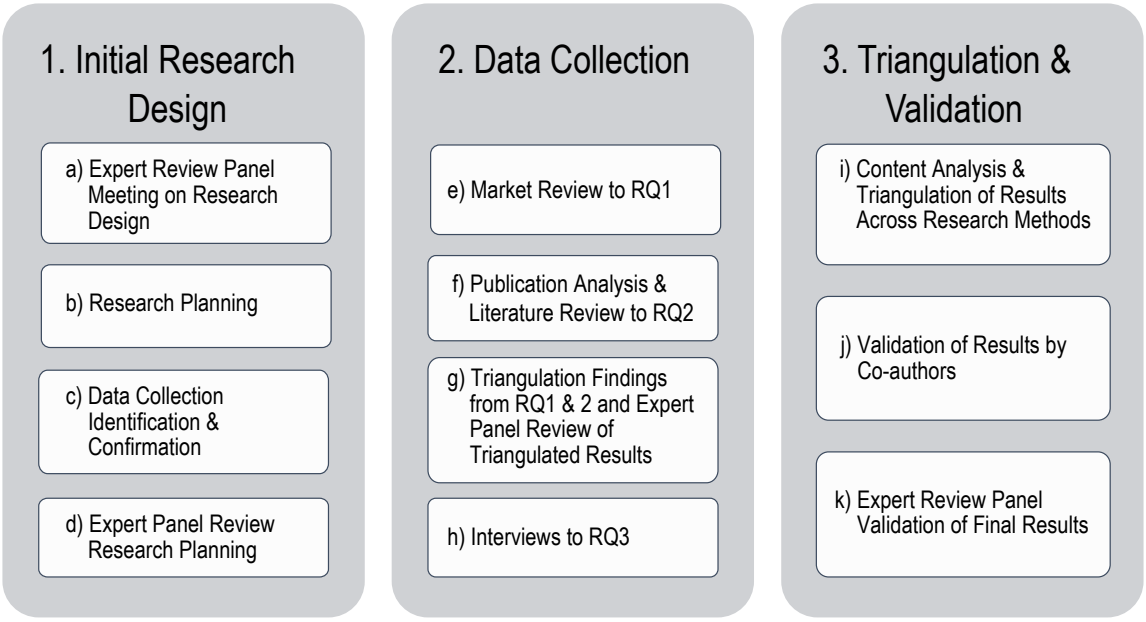

Figure 3. Research design in three stages: (i) initial research design, (ii) data collection, and (iii) triangulation and validation, for steps a-k. Source: Authors.

- Two state-of-the-art analyses were conducted, for current market developments and recent research developments, to inform an interviews approach and validate its results.
- Interviewees were selected initially by the Expert Review Panel and further interviewees added based on interviewee recommendation and agreement with the Expert Review Panel.
- Multiple researchers reviewed coding outcomes from interviews, which were recorded digitally and transcribed.
- Convergence in interview responses on a given threshold is disclosed (as defined in Section 3.3) and aligned with the outcomes for RQ2 to determine key themes.

3.1 Research Question 2: Publication analysis and literature review

Research output during the review period (2014–2019) was collected for a selected group of researchers (list of researchers in Appendix B) using digital libraries and keywords to determine the state of the art.[4] The following criteria were applied to analyse the publications:

- Author located from within the sub-group research cluster;
- Published between 2014-2019;
- Published within the top 10% percentile of journals; and
- Addressed a key topic identified in Toppinen et al. (2017a).

An analysis of topics and keywords was also conducted for all publication search results, using SciVal [5] and manually for comparison by the author from data originating in Scopus. SciVal metrics for grouping publications by keywords and themes for analysis were automated according to the publisher's own methodology described in Elsevier (2019). Manual keyword clustering was also completed, by listing like-pairs of keywords in clusters for keywords appearing more than once (i.e., 2+). Keywords related to methodologies were excluded, as were any that were unclear (e.g., "management" can refer to either environmental or corporate forms). The keywords generated by these different analyses were then used to develop the interview framework for RQ3.

A targeted list of 20 publications were selected from the total search results, based on the articles' impact ranking as defined by SciVal, which was reviewed and approved by the Expert Review Panel before proceeding.[6] Each article was reviewed individually and as part of a group under a set of thematic headings identified during the market review and the keywords as indicated by the publication analysis results. Most of the articles were led by researchers from the faculty in the research groups, but some were written through collaborations.

3.2 Research Question 3: Expert Interviews

Interviewees were selected through dialogue with the Expert Review Panel. A total of 10 interviews were conducted out of 13 contacted prospective interviewees. The invited interviewees were sought in order to cover the spectrum of perspectives on the theme of the review from within the Faculty of Agriculture and Forestry, and only a few of the interviewees had articles selected for in-depth review. All interviewees were adjunct, tenured, or full professors working in or in close contact with the topic of the review. The interview guide (see Appendix B), developed from the results of RQs 1 and 2, covered a range of open-ended questions on the themes and keywords highlighted in this review. Interviews lasted approximately 1 hour and were recorded and transcribed. Each interviewee was provided the interview guide in advance.

Qualitative content analysis (QCA), a method proposed by Schrier (2012), was used for identifying themes within the interview response data and to account for frequencies. Coding of the interviews was done using inductively and deductively grouped and categorized phenomena. During the process of interviewing, many of the findings were saturated, meaning that the total sample size was deemed sufficient. In presenting the results, convergence among interviewees regarding coded statements is noted in the article text. Only statements with *high (>5/10 respondents)* and *medium* convergence *(<5 but >3/10)* on the same points by interviewees are noted. The *low (<3/10)* convergence statements are not included in this article. Interview outcomes are presented consistently at the end of each results sub-section.

4 Data span was chosen to match publication of Finnish Bioeconomy Strategy in 2014.

5 SciVal is an Elsevier tool for publication analysis, which "enables you to visualize research performance, benchmark relative to peers, develop collaborative partnerships and analyze research trends" (SciVal 2020).

6 This expert was not interviewed.

4. Results and Discussion

Results for RQ1 were the case study background, integrated to this article as the Introduction and Theoretical Setting (Sections 1 and 2). This section presents the results from RQs 2 and 3, separated as the publication analysis (Section 4.1) and the resulting key themes from literature review and interviews (Section 4.2).

4.1 Research Question 2: Publication Analysis Results

According to the publication analysis, the extent to which UofH's research is impactful in its field of scientific literature and aligned with current competitiveness themes faced by the industrial forest sector was considered high during the review period. Competitiveness-specific research was analysed according to the defined criteria (Section 3.1), with 259 peer-reviewed publications having a field-weighted citation impact[7] of 1.89 and an average of 9.2 citations per publication (Table 1). Topic areas identified by SciVal metrics demonstrated alignment to the Academy of Finland themes as presented in Section 1, with innovation, sustainable development, and socio-technical transitions themes in industrial forest sector competitiveness increasing in importance.

Sustainability, knowledge sharing, and networks did not feature in the top 5 topics, but did feature in the top 10 topics (Table 1). Monitoring and reporting of sustainability information featured at 6th on the list, with sustainable business development (11), disclosure (12) and innovation (14). Bioproducts were mentioned in the context of wood/timber (8) and by or sub-products (3, 4, 10, and 13). Alternative forest service options were considered in the clusters about deforestation and communities (7) and on ecosystem services (9). However, the lower absolute output by topic does not translate into a lower impact overall. Topics indicated close linkages with circular and bioeconomy concepts, various aspects of value chain, from security of the wood supply to products and processes, as well as the growing importance of innovation, sustainable development, and socio-technical transitions. This suggests a strong alignment with the themes of renewal in industrial competitiveness.

Field-weighted impact and publication prominence of the selected research contributions demonstrated the high value added in sustainability transitions literature (Table 1). The impact on servitization (e.g., ecosystem service literature) scored highest in terms of field-weighted citation impact (6.42) among the list of 14 topics. It was followed by sustainability disclosure by firms (3.88) and sustainable development literature (3.78). This trend was also reflected in its global prominence scoring, where corporate responsibility (99.9th percentile), ecosystem service (99.9th percentile), sustainability disclosure (99.7th percentile) and innovation and socio-technical transitions (99.9th percentile) all scored highly. The results indicated that industrial competitiveness research at UofH increasingly investigates sustainability transitions dimensions, as the urgency of global sustainability challenges has gained prominence.

For alternative comparison, manually clustering publication keywords by incidence, according to the 259 publications, demonstrated that forest management, products and services, sustainability, competitiveness and economy were the themes within the top 5 (Table 2). In total, 119 of 160 identified keywords were clustered. Servitization, sustainability, competitiveness, and economy featured on the list in terms of associated keyword prominence. Manual clustering highlighted the importance of sustainable transitions, sustainable development, and competitiveness themes in faculty research output, demonstrating that the majority of the 15 keyword clusters deal with these topics in various aspects, as they relate to forestry and the industrial forest sector. It further supported the outcomes of the SciVal approach to publication analysis.

4.2 Research Questions 2 and 3: Key themes from literature review and interviews

4.2.1 Theme 1: Sustainability as an opportunity for forest sector competitiveness

Changes in production approaches (e.g., shifting to the Global South) and sustainability awareness were found within the published research and interviews as affecting competitiveness and reputation for Nordic industrial forestry firms. According to interviewees, cost competitiveness was viewed as important but as a narrow definition for industrial competitiveness with very few new factors. Rather, external factors beyond the organization have a growing importance and role for driving industrial competitiveness during the current moment of history.[8] Equally, environmental sustainability was viewed

7 Field-weighted citation impact (FWCI) is the ratio of the total citations actually received by the denominator's output, and the total citations that would be expected based on the average of the subject field.

8 *High convergence, 8/10, among interviewed respondents.*

Table 1. Topics of research within the competitiveness sub-group with output above 4 articles, 2014-2019, as identified by SciVal.

Topics, in ranked order		# of articles	Field-weighted citation impact	Global prominence percentile *
1	Forest, forests, forest landowners	18	3.75	90.8
2	Certification, forest, certified wood	11	1.62	94.6
3	Cellulose, lignin, hot water	9	1.12	93.7
4	Leuconostoc, dextran, acid bacteria	9	1.74	91.7
5	Food, diet, animal products	7	2.22	99.7
6	Corporate social responsibility, CSR, social responsibility	6	0.74	99.9
7	Forest, deforestation, community forests	6	1.83	98.9
8	Wood, lumber, softwood lumber	6	1.36	75.3
9	Ecosystem service, ecosystem services, multiple ecosystem	5	6.42	99.9
10	Aerogels, cellulose, cellulose aerogels	5	1.20	96.9
11	Sustainable development, biomass, economic growth	5	3.78	96.4
12	Corporate social responsibility, disclosure, environmental disclosure	4	3.88	99.7
13	Lignin, cell walls, lignin biosynthesis	4	1.62	98.2
14	Innovation, sustainable development, socio-technical transitions	4	1.99	99.9

* Global "prominence is an indicator of momentum/movement or visibility of a particular topic calculated" by SciVal. If the research topics addressed by an institution are in the top percentile, then it demonstrates that the selected institution is highly active and leading in a field of research that also has considerable momentum. SciVal provides the following definition for calculating a topic's prominence, combining three metrics to indicate the topic's momentum: (1) citation count in year n to papers published in n and n-1; (2) Scopus views count in year n to papers published in n and n-1; and (3) Average CiteScore for year n.

Table 2. Keyword clusters as identified by the author for competitiveness research by the sub-group, 2014-2019.

Keyword clusters	Keyword cluster descriptor	Occurrence for clustered keywords
Forestry, forest management, forestry practice, plantation forestry, forests, forestry production, land use, eucalyptus	Forestry	71
Innovation, forest product, forestry services, products, new product launch, bioenergy, bio-energy, ethanol, packaging, packaging materials, furniture, wood, timber, wood products, wooden construction	Products and services	65
Sustainability, sustainable development	Sustainability	54
Competitiveness, competitive advantage, competition, corporate strategy, costs, future prospect, investment(s), strategic approach, business development, business ecosystem, business opportunities	Competitiveness	49
Bioeconomy, circular economy, green economy, commerce, economics, business, small and medium-sized enterprise	Economy	44
Chemistry, metabolism, tensile strength, cellulose, exopolysaccharide(s), plant protein, water vapor permeability, alcohols, barrier properties, elastic moduli, mechanical properties, elongation at break, films	Biophysical and chemical properties	41
Stakeholder, consumers, perception, consumption behavior, consumer, co-creation, human(s), environmental perceptions, environmental awareness, health	Stakeholders	33
Ecology, ecosystem(s), nonhuman, ecosystem service(s)	Ecosystem	33
Forest industry, forest sector(s), pulp and paper industry, construction industry, timber industry, construction business, food industry	Industrial sectors	30
Environmental impact, economic and social effects, environmental impacts, environmental indicator, environmental performance, dependency, environmental issue, environmental sustainability, carbon, carbon footprint	Non-financial impact	30
Finland, China, Sweden, Europe	Geography	25
Environmental management, environmental protection, conservation, climate change, biodiversity, environmental regulations, environmental policy	Environmental management	25
Corporate social responsibility, corporate social responsibilities (CSR), communication, corporate responsibility, corporate sustainability, environmental communication	CSR	24
Forest certification, certification, sustainable forest management, timber certification, environmental certification, eco-friendly products	Certification	15
Nonindustrial private forests, non-industrial private forest owners, forest owners	Forest ownership	9

as mutually exclusive to financial performance among forestry firms, with climate change being the major sustainability "megaforce" under consideration (Pätäri et al. 2016). This indicates an alignment between researchers and industry on sustainability being a priority for both forestry sector competitiveness and in current research.

To effectively internalize these changes to business models and processes, environmental policy predictability and stability were seen as important for the forest industry (Korhonen et al. 2015). A proactive environmental policy approach by some firms to such challenges has been shown to correspond with active communication, including product recyclability, measuring carbon footprint, energy use, and promoting research and development activities (Räty et al. 2016).

Climate change is often viewed as an opportunity internally to many industrial forest firms; a basis for transitioning to more sustainable business practices (Pätäri et al. 2016). Firms view their role towards addressing climate change as to include mitigation via material substitution, bioenergy, recycling and material efficiency. According to interviewees, this shift affects entire business models, and increasingly new networks are important, but most new networks are often only in niche areas.[9] In the reviewed literature, industrial representatives were the most adamant compared to other expert groups (governmental, research) about the role of climate change and energy as megaforces driving changes in the sector (Korhonen et al. 2015). There is also a growing awareness of environmental issues among consumers, which is seen by forestry firms as an opportunity for competitive advantage by firms with high environmental standards (Korhonen et al. 2015). This underlines the managerial belief that sustainability is part of competitiveness and competitive advantage, and supports the conceptual underpinnings from Toppinen et al. (2017a) on how to operationalize the long-term view on competitiveness.

There is also a strong, though not fully realized, role for government institutions within the forest value network during the sustainability transformation, acting as a catalyst for innovation and renewal through policy predictability and stability (Korhonen et al. 2015). In turn, proactive and intrinsically motivated firms can also manifest action through internal environmental policy seeking the implementation of environmental communication and managerial and strategic attitudes on environmental performance. Räty et al. (2016) found proactive firm behavior went beyond labelling, while neutral firms restricted their communication and often relied only on labelling. Small and medium-sized, value-added firms and Do-It-Yourself stores were more often proactive or neutral, in contrast to retailers and construction firms who were predominantly neutral or passive. Environmental certificates were perceived as important, but used more in B2B than consumer export markets. The key benefits from a proactive environmental policy included resource efficiency, changing customers' preferences, waste management and raw material origination. Such managerial level aspects of forest sector renewal and sustainability transitions should come forward, according to interviewees, in research output and engagement (e.g., effect of non-foresters leading major incumbents) to support adaptive planning and mitigate short-termism.[10]

4.2.2 Theme 2: Proactive environmental action by firms includes mechanisms to reduce and efforts to disclose value chain impacts

There is a persistent perception of Finland as having the best managed forests, forming part of a belief that Finland is already being sustainable,[11] according to the interviewees. To address these beliefs, they asserted that there should be a focus toward radical rather than incremental changes, as the time for optimism is decreasing with future emphasis on both climate change mitigation and adaptation having material consequences.[12] For efficient use of wood in climate change mitigation by industry, the carbon sink in the forest, long-term storage in wood products, and avoided emissions through substitution should all be maximized (Soimakallio et al. 2016). To expand the carbon sink, ecosystem service market participation by forestry firms in the Nordic region can result in limitations to asset market liquidity, meaning there is not a win-win for all market participants (Matthies et al. 2015). One means for achieving these objectives is through sustainable forest management (SFM) certification, linked with EU bioeconomy-linked policies and regulations seeking to reduce the impact of forestry utilization.

According to Soimakallio et al. (2016), the direct impact to the carbon emissions balance from wood harvesting in Finland (in 2010) was greater than the

9 *Moderate convergence, 4/10, among interviewed respondents.*
10 *Moderate convergence, 4/10, among interviewed respondents.*
11 *High convergence, 7/10, among interviewed respondents.*

combined direct emissions from wood utilization (i.e., substitution effect, which created a significant reduction in net emissions, but not enough to offset lost growth) and fossil fuel use in industrial production. Thus, the alternative "no harvesting" scenario had lower impact overall than all scenarios that included harvesting. These results indicate that changes in management and harvest processes in Finland may be required to meet the forest sector's climate change mitigation targets, but finding solutions that both researchers and industry agree on and that firms initiate proactively can be challenging.

Impact offsetting and SFM certification provide two mechanisms to achieve those objectives. Interest in carbon and biodiversity offsetting via forests in Finland is growing, but the benefits of carbon offsets for investors and forest owners relative to traditional forest income (e.g., timber harvesting) may be limited. According to interviewees, firms should retain ownership of the service vehicle (e.g., carbon ownership is a competitive advantage).[13] Matthies et al. (2015) found the financial and diversification benefits from offsets were low at the stand level but increased as the landholding area increased. Fertile sites were optimal for receiving payments, creating a trade-off with timber production, while low correlations between offsets and timber markets overall support the move toward diversifying cashflow streams. Alternatively, SFM certification adoption, which also creates voluntary forest conservation areas, contains benefits of market differentiation, reputation and brand image, value chain communication and supplier relationships (Tuppura et al. 2016). This can create both strategic and profitability motivations for firms, while clients requesting SFM certification indicates instrumental and institutional motives.

Customer demand and expectations, policy, and regulation have all been cited as important external factors driving SFM adoption. However, industry-level barriers for sustainability transition action are often linked with insufficient customer preferences toward sustainable products and policy and regulation uncertainty (Räty et al. 2016). Thus, there is a tendency toward being reactive, responding largely to external pressures, rather than proactive environmental behavior among industrial forest firms, which should be addressed to ensure competitiveness is sustained during a potentially rapid sustainability transition. Corporate profiles oriented toward strongly sustainable transitions within the industrial forest sector were also viewed by interviewees as limited, and that there is not always a strong push to alter this by incumbents.[14]

Lähtinen et al. (2016a, b) examined corporate reporting on such environmental issues by large and small forestry firms. Large firms tended toward reporting of indirect impacts (77%) rather than direct impacts (i.e., on biodiversity and ecosystem services) and positive case studies (81%) over negative ones. Resource efficiency and renewability were important co-benefits with environmental management actions, with strong emphasis by firms on SFM certificates and other conservation programmes. Monitoring methodologies and uncertainties around environmental issues were not transparently reported by the large firms. Reporting was focused toward actions within a broader value chain scope and positive orientation, demonstrating an imbalance between reporting and the scale of environmental challenges like climate change and biodiversity loss facing most forest sector firms. There was also lack of common economic, social, and environmental criteria and indicators among small firms (Lähtinen et al. 2016b). Divergences in social indicators (e.g., workforce, working conditions and safety) and environment (e.g., water, energy) meant that respondents, among smaller firms, did not perceive environmental sustainability as critical to their business operations or markets. To better integrate environmental sustainability to external communication more broadly and the quantification of negative impacts will require a greater level of strategic insight and awareness among the actors in Finnish forest value chains toward the role of such disclosures in terms of engaging stakeholders.

Understanding the impacts of industry internationalization on competitiveness extends analysis beyond the boreal forests, with many of the Nordic industrial forestry companies having operations in the Global South. According to a global meta-review by Malkamäki et al. (2018), the socioeconomic impacts of such large-scale tree plantations are many and varied. The greatest number of impacts have been on employment, land, livelihoods, and social impact feedbacks. These results support the view that displacement of locals during the plantation establishment phase is a major social impact, which has effects both in terms of lost local livelihoods and access to land. Although there are challenges to

12 *High convergence, 7/10, among interviewed respondents.*

13 *Moderate convergence, 4/10, among interviewed respondents.*

14 *High convergence, 7/10, among interviewed respondents.*

achieving a proactive approach toward mitigating and disclosing against negative impacts, the Nordic and Finnish forest industry has a long tradition of overcoming global and local challenges in wood supply, according to interviewees. Future forest competitiveness research should include managing new risks (e.g., demographics, climate), certification challenges, and more emphasis on downstream activities (e.g., consumers) helping to manage more a radical transition successfully.[15]

4.2.3 Theme 3: Realizing innovativeness and industry renewal requires transformative change

Value-added products and services are viewed as important means for improving industrial competitiveness according to interviewees, with a focus on new margin and profitable growth. Academic research has explored both product and service market potentials and limitations, supporting this development (e.g., Alekhina et al. 2014, Dahlbo et al. 2015). However, innovation in the Nordic and Finnish industrial forestry context is still limited and innovation systems uncertain, with the focus of incumbents still on bulk and low value added. That has effects on innovation orientations, technology lock-ins, lack of long-termism in product development and timber market developments.[16] To overcome these challenges, research indicates that adopting new paradigms is important for supporting competitiveness and resilience.

Key themes emerging to support the Finnish forest sector's sustainability transition include green, circular and bioeconomy paradigms. D'Amato et al. (2019) investigated how corporate reports used these themes, finding that circular economy was utilized abundantly, for efforts such as eco-efficiency and innovations, focusing on (1) monitoring/assessing; reducing/optimizing; (2) recycling/ reusing of energy; and (3) material flows. For the bioeconomy, use centered around (1) bio-based energy and fuels; (2) higher value use of biomass; and (3) biosecurity. Taken together, very few linkages were found between the use of these concepts as reported by firms, opening for further development a combined paradigm for a "circular bioeconomy". Such a paradigm could support bio-based themes of product and service innovation, while integrating the sustainability dimensions of industrial competitiveness. Interviewees noted that a new focus taking on global and radical sustainability transformation questions is a high priority (e.g., the climate crisis), with new growth paradigms (e.g., no growth), new value networks of actors, new innovations and knowledge sharing between actors required.[17]

Support for the development of future products and services oriented toward circularity and long-term use of wood (e.g., wood construction and bio-materials) have scored favorably among forest industry actors (Korhonen et al. 2018b). However, upon further exploration, key product and service categories include sawn wood and pulp and paper products, the traditional mainstays of Finnish industrial forest product mix. Services and packaging solutions also score highly, with marketing ranked as a core aspect to enhance these by industry actors. To support commercialization of circularity and longer lifespan of products are dimensions noted by firms for emphasis (e.g., wooden construction and bio-materials). Mattila and Roos (2014) indicated large incumbent service organizations are favored by market dynamics and forest ownership, making them slow to adapt, with limited customer orientation. Instead, service providers often view forest owners as material providers rather than customers. These results contrast with D'Amato et al. (2019), demonstrating the role of managerial-level engagement beyond only corporate reporting, where perceptions, knowledge and capacity toward the sustainability transition can be more granularly assessed.

Toppinen et al. (2017b) found that forest industry stakeholders viewed innovation more positively and this view was more widespread than 10 years earlier, with new products by network actors contributing between 30% and 75% of turnover in 2030 (average 61%). The highest estimates came from industry associations and industry experts. Changes included substantial shifts in strategic partnerships within value networks. For future scenarios, product portfolio diversification through niche markets and high-value-added products were important considerations. However, a high level of divergence between industry actors' perceived capacity to realize these shifts by 2030 and researchers indicates a high level of uncertainty for the sector. A radical shift in the business logic may be required to achieve the required changes in the product portfolio. Interviewees and literature reviewed demonstrate a major divergence between researchers' perspectives and the actions of

15 *High convergence, 7/10, among interviewed respondents.*
16 *High convergence, 6/10, among interviewed respondents.*
17 *High convergence, 7/10, among interviewed respondents.*

incumbent forestry firms in the theme of realizing innovativeness and industry renewal.

An important factor limiting such a transformation of the sector is the density of local and regional bioeconomy value networks. Korhonen et al. (2108b) identified the Finnish industrial forest network as being high and divided in two sub-groups, (1) a research–national institute-NGO group; and (2) an industry–government–other group. The former had higher levels of communication and knowledge sharing among actors than the latter. Large industrial firms are central organizations, while other periphery actors included research, NGOs and consultancies in the latter group. The network was centrally steered in a top-down manner by government agencies and industrial actors, who advocated their own policy interests. Such a structure may be detrimental to long-term innovation and inclusive knowledge transfer, which can impact on the adaptability and resilience of the sector in competitive markets.

The interviews also emphasized the pathways, networks, adaptive capacity and scenarios required for future academic research orientations. Such research supports industrial competitiveness orientations by leading in ambition setting, to be prioritized and accepted by internal and external actors and built on, as it helps to orient toward what is the end goal for stakeholders and/or society.[18] Sustainability aspects of academic research (e.g., futures research, sustainability transitions) should be central to forest industry renewal and associated policy making debate and decision-making, focusing on adaptive governance and futures research, especially given rapid sustainability transition periods and potential chronic crisis/disruptions (i.e., in markets).[19]

4.2.4 Theme 4: Transition requires knowledge sharing by firms towards stakeholders

Research indicates the importance of knowledge sharing between suppliers and buyers for increasing stakeholder awareness about sustainability dimensions in forest value chains and expanding beyond current value networks (e.g., Wang et al. 2014). To overcome market prejudices towards timber use (e.g., susceptibility to fire, warping and shrinkage, history of concrete use) may require better knowledge sharing about timber products from the supplier side. However, a slow response and development by industries to meet demand and uptake for wood-based product utilization has been viewed, almost unanimously, as a hindrance to innovation diffusion by Franzini et al. (2018). Technical and financial aspects and the end-user preferences are also important considerations in firms seeking to better share knowledge about their product and service innovations (Franzini et al. 2018). Service offerings to customers should also have a material impact on business outcomes by addressing the heterogenous nature of individual preferences through personalization and differentiation (Kaptein and Parvinen 2015). As a result of growing awareness and change in perceptions of consumers toward a bio-based economy, there is also growing support among Finnish citizens toward bio-based products, e.g., for bioenergy compared with fossil fuel-based energy (Vainio et al. 2019). Renewal of the energy markets and consumer awareness were key drivers in preferences, with small-scale production and domestic bioenergy power in rural areas seen as important. This underlines the rural employment dimension of the bioeconomy, where biomass energy production is an important component in Finland. Interviewees of this study also noted the importance of stakeholder management as an aspect of competitiveness, in order to outreach to and inform consumers about quality and Finnish value added in environmental and social considerations (e.g., welfare, income distribution).[20]

5. Conclusions

Past research by and interviews with UofH researchers in the assessment of and support towards transformation of the industrial forest sector in Finland and the Nordic region was indicated by the publication analysis and across the four themes presented. This research was built on the orientations outlined by the Academy of Finland themes (Appendix A), including, *inter alia*, networks, value co-creation and innovation, stakeholder values, and sustainable and efficient resourcing pathways to ensure both adaptation and adaptability. Notably there were similarities to the views from industry research on the first theme, as to the role of sustainability toward industrial competitiveness, while divergences emerged on the latter three themes. For resource utilization and the reduction of negative impact (theme 2), product and service innovation and

18 *High convergence, 7/10, among interviewed respondents.*
19 *High convergence, 7/10, among interviewed respondents.*
20 *High convergence, 6/10, among interviewed respondents.*

proliferation (theme 3), and the importance of engaging value chain stakeholders (theme 4), interviewed researchers suggested a greater importance and more radical transformation than did industry. Still, the importance of these themes was recognized by industry through the existing research.

The key findings that emerged through this case study were the growing perception among researchers that increasingly radical sustainability orientations are required to transform the sector, as evidenced by articles published from the end of the 2014–2019 review period compared with those published in the beginning of the period, and that a higher drive for transformative change was identified among interviewed academic experts than what could be concluded about the industry studied. This could be a cause of concern also from a research funding perspective if the academy continues to focus less on practical industry development needs and more on high-profile scientific ambitions.

Thus, there are reservations as to whether incumbent firms are sufficiently ambitious to harness the emerging opportunities. This observation is important not only for guiding forest industry managerial decision making, but also nationally, as Finland seeks to diversify its economy and broaden and deepen the integration of networks beyond traditional value chains. Barriers to more radical sustainability action within firms were found to be tied with extrinsic motivation for sustainability or reactive approaches to external factors, such as customer expectations.

The sustainability transformation has increased uncertainty in many industries, including forestry, requiring innovativeness, the uptake of new materials, and the establishment of collaborations throughout the value chains. Recent advancements in European industrial policy (e.g., the European Battery Alliance) demonstrate that these challenges can be overcome through targeted action. The paradigm shift in research orientations, as evidenced in this case study, can feed into the broader commercial renewal through knowledge sharing and educational development. As key takeaways, we conclude that sustainability contributes to competitiveness and market access over the long-term. A more radical transformation is thus needed, relying on proactive sustainability management and strong investment toward new product and service development, in order for forest industry firms to become champions in the circular and bioeconomy paradigms.

6. Limitations

The authors acknowledge that the focus on a single case institution provided a limited scope for review without a peer comparison. However, by assessing the output of the institution on three RQs, the case study examines in greater detail how individual research items contribute towards understanding different factors within a broad theme – *industrial competitiveness*. Further, we could contrast researcher groups' past outputs with their views to future orientations to better understand the emergence of new or the strengthening of existing themes. By continuing to critically explore these research orientations, academic research has a continued importance for the Finnish and global industrial forest sector. Methodological options for how to carry that out are found to range from futures research exploration of new pathways to the evaluation of scenarios that link socioeconomic and environmental changes.

Naturally, using our (or any other documentary-based) approach, it is not possible to address to what extent the research has actually been used by the industry itself to gain higher competitiveness. A more fine-tuned analysis is called for in developing more explicit managerial recommendations to improve the competitiveness of the different segments of the forest sector and build firm-specific strategies. Despite this, our review reflected a wider scope of research conclusions, going beyond a dissertation level connection of articles to connect closely oriented outputs across research groups, while retaining granularity not found in a broader faculty or university level research review. It explored the broader publication record for a subset of researchers focusing on topics relating to industry competitiveness in one of the leading forestry countries in Europe, and by doing this, pinpointed the relevance for a sustainability transition, particularly under the bioeconomy and circular economy paradigms. A more specific limitation, the topic of integrating preferences by and knowledge from stakeholders, appears as an issue that would be better tackled with other data and methods than the literature review and researcher interviews done here, and those results are therefore not conclusive.

As a whole, the gained case-based evidence from the perspective of one leading academic institution provides a potentially valuable benchmark for similar reviews to determine how research on this topic is evolving in different geographic, political, economic and social contexts.

Future research should also complement this by focusing on the inclusion of viewpoints from other stakeholders (e.g., firms from different segments, governments, trade associations, NGOs, consultants, etc.) about how much and in what ways academic research has supported the development of the national forest bioeconomy.

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Appendix A:

Academy of Finland report on bioeconomy research paradigms

Systemic changes in the bioeconomy:

- Value networks
- Biorefineries and product portfolios
- Cross-border resource efficiency
- Durability of protein production and consumption
- Consumption as a force for change

Products, services and concepts of bioeconomy:

- Modular local production
- Technically and economically sound raw materials
- From nature to holistic well-being

Biomass availability and ecosystem services:

- Security of supply
- Optimal use of material flows
- Powerful surfaces
- Blue-grain economy
- Tailored biomass

Scientists in science and technology:

- Modular mobile local production
- Enabling technologies in the bioeconomy
- Bio-based compounds and substances
- System changes, value networks reform
- Tailored biomass

Researchers in culture and society:

- A critical review of the bioeconomy
- Creation and implementation of innovations in the bioeconomy
- Citizen in the bioeconomy
- Changing values
- A value choice for a sustainable resource economy

Appendix B

Supplementary Information

1. Research Design

Research design was based on iterative meetings, email exchanges and reviews with the Expert Review Panel and co-authors. Initial results, triangulation of secondary outcomes and final validation, as outlined in Figure 4 of the article, was done in accordance with the three research questions and associated methods outlined in Figure 2.

2. Market Review

Research Question 1: In what ways is country X's position as a global supplier of sustainable forest products competitive in the "current snapshot"?

A market review was conducted building on the conceptual lens in Figure 3. Key themes included, inter alia, forest management certification, Nordic-Baltic economic convergence, Finnish industrial forest cluster, new products and services, the circular bioeconomy and climate change. Multiple data sources were used, ranging from media to peer-reviewed articles and statistical databases, to build a snapshot state-of-the-art of the industrial Finnish forestry context. Market review outcomes were compiled and used to inform the triangulation and validation of results from the methods applied to research questions 2 and 3. It was used to identify and validate the themes by which literature were grouped in the publication analysis and literature review. To do this, the key themes identified by the market review were presented to co-authors and Expert Review Panel members by email and discussion to review, debate and validate as key themes in the context of the Finnish industrial forest sector. The market review was condensed into the introduction section of this article.

3. Publication Analysis & Literature Review

Research Question 2: To what extent and in what ways is the "current orientation" of research in Faculty X aligned with the "current snapshot"?

a. Publication Analysis

The following persons were included in the list of sub-group researchers:

- Toppinen, Anne
- Valsta, Lauri T.
- D'Amato, D.
- Parvinen, Petri M. T.
- Berghäll, Sami
- Korhonen, Jaana E.
- Lähtinen, Katja
- Salo, Jari
- Karppinen, Heimo
- Korhonen-Kurki, Kaisa
- Mattila, Osmo
- Hukkinen, Janne I.
- Häyrinen, Liina
- Rekola, Mika
- Matthies, Brent D.
- Holopainen, Jani Markus
- Vainio, Annukka
- Tuomisto, Hanna L.
- Li, Ning
- Wan, Minli
- Heinonen, Visa
- Tenkanen, Maija

b. Literature Review

Articles were reviewed as follows, first read of the article, searching for key information about the research question, background and theoretical framework, method, results and conclusions as they related to the topics identified in interview framework figure and competitiveness. Key information was placed in summary texts of approximately 250-500 words, which were then analysed as a grouping under a thematic heading aligned with the themes identified in the market review through validation with the co-authors and Expert Review Panel. Thereafter, the summaries were integrated into a thematic summary as presented in the Results and Discussion.

Selected articles ranged from 2014-2019 with a range of contributing authors and author leadership. Majority of the articles were led by researchers from the Faculty, but some were written through collaborations

with outside organisations or universities in Finland. Results of the publication analysis and literature review were triangulated, including the keywords identified, and included in the interview framework development. In this way, the interviews built on the existing market and research contexts to inform discussions about current and future research dimensions.

4. Interviews & Interview Framework

a. Interviews

The interview framework (next section) was developed after concluding the results of RQs 1 and 2. A draft was reviewed by co-authors and the Expert Review Panel. The framework covers the purpose of the study, the background theory, definitions, and data collection approach. The interviewees were selected by confirmation with the Expert Review Panel. Each participant in the interviews was provided the framework in advance (at the time of agreeing the interview via email). A total of 10 interviews out of 13 contacted prospective interviewees were conducted (77% response rate). All interviewees work in or in close contact with the Faculty on the issues related to competitiveness. The following persons were interviewed from the Faculty for this review:

Interviewee Titles	Aggregate Number Interviewed
Professor Emeritus	1
Professor	7
Associate Professor	1
Adjunct Professor	1

There were a total of 5 structured headings with introductory and open-ended questions and one 'other' category:

1. Personal definition of competitiveness
2. Research roles
3. Research outputs
4. Research futures
5. Research priorities
6. Other

Half of interviews were conducted face-to-face (5/10), with the reminder carried out via phone. The interviews lasted 1 hour each. All interviews were recorded using a phone app and transcripted into written copies for review through a purchased service. Transcripts were reviewed and excerpts compiled in an Excel spreadsheet to provide an overview of the structure of the results. The primary researcher assessed the outcomes to compile the key issues by topic heading. After compiling the findings by heading, coding the responses and compiling preliminary findings, the initial results were reviewed by a second researcher, an external expert in the field of Finnish forest sector competitiveness.

Coding included inductively and deductively grouped and categorised phenomena. Qualitative content analysis (QCA) method proposed by Schrier (2012) was used for identifying themes within the response data and accounting for the frequencies. The themes were identified through concurrent and iterative review of the transcripts from the interviews. Transcripted texts were copied to an Excel and reviewed together with the outcomes of the other interview responses. The responses were compared to determine any emergent themes and clustered according to the themes identified using the identification of shared keywords, concepts and orientations associated to the identified themes to determine the level of convergence by the interviewees. The obtained themes were then compiled into a second Excel sheet and convergence frequencies were calculated.

During the process of interviewing, many of the themes were saturated (i.e. >50% of the interviewees mentioned and converged on the same themes) meaning that the total sampling size was deemed sufficient. In presenting the summary of the interviews, convergence was noted (amount of interviewee's responses that converged on the theme statement). An indication of the number of interviewees who converged on the same points during their interviews is given (high = >50% of interviewees, moderate = >20% and

<=50%, low = <20%). Convergence was defined as stating the same response theme to the same question asked to other interviewees, an example of the second Excel results with themes and convergences is provided here:

Theme	Research Futures (Future Themes)	Number of Converged Responses
1	New focus taking on global and radical sustainability transformation questions is high priority (e.g. climate crisis, biodiversity crisis, new growth paradigms (e.g. no growth), new value networks of actors, new innovations and knowledge sharing between actors)	7
2	Managerial level aspects of forest sector renewal and sustainability transitions should come forward in research output and engagement (e.g. effect of non-foresters leading major incumbents) to support adaptive planning and mitigate short-termism	4
3	Forest industry has a long tradition of overcoming challenges in wood supply, but future research should include new risks (e.g. demographics, climate), certification challenges and more emphasis downstream activities (e.g. consumers). Ability to address these questions uncertain.	5
4	Currently there are numerous unresearched areas (e.g. sustainable finance) and underresearched areas (e.g. effects on land opportunity costs during sustainability transition, effects of rapid adaptation and landuse lock-ins), especially in social sciences (i.e. due to limited competencies)	8
5	Servitisation and digitalisation are key future themes to continue developing	2
6	Rapid policy making cycles should be a focus, taking into account long-term path dependencies and adaptive governance in public and private strategy and policy development	4

The final results of the coding and presentation of the interview results was validated with both co-authors through review and the Expert Review Panel via presentation of the results and a group discussion.

5. Interview Framework (as presented to interviewees)

The aim of this research is to benchmark the Faculty's expertise and experts in research relative to the current and projected future research paradigms in forest sector competitiveness focusing on industrial development. The final report will examine effects from the policy environment, market dynamics, and global megatrends driving or impacting on the emerging range of commercialised forest products and services, including forest cluster growth, product innovation, and supply chain integration. The framework for competitiveness shown in Figure 2 is used in this study to frame what research outputs and research groups are included in the analysis.

The following European Commission definitions used in the context of this research:

1. **Competitiveness:** *the ability of a country (region, location) to deliver the beyond-GDP goals for its citizens (Aiginger, 2013)*
2. **Beyond-GDP goals**: *measures that go beyond economic to include environmental and social aspects of well-being (e.g. Sustainable Development Goals) (European Commission, 2019)*
3. **Bioeconomy:** *the production of renewable biological resources and the conversion of these resources and waste streams into value added products, includes traditional agriculture, forest, fishery, food and pulp and paper value chains (European Commission, 2012)*
4. **Circular economy:** *starts at the very beginning of a product's life" where both the design phase and production processes have an impact on sourcing, resource use and waste generation throughout a product's life (European Commission, 2015)*

Interview Questions:

1) **DEFINITION OF COMPETITIVENESS:** In your view, what does "competitiveness" mean in the context of Finnish industrial forest sector?
    a) List some key words in describing:
        i. Competitiveness (beyond GDP)
        ii. Finnish industrial forest sector (circular bioeconomy)
        iii. Future economy & society
2) **RESEARCH ROLES:** In your view, what role do you see for research and researchers in supporting, researching and reflecting on the competitiveness of Finnish industrial forestry and its development over time?
    a) In what manner is that role currently being expressed within the Faculty? Could it be improved? If so, how?
    b) Is there currently a close linkage with the private actors in the sector? If not, how could research more closely relate to their needs? What actions should be taken to achieve that?
3) **RESEARCH OUTPUTS:** What have been key outputs of your / your research group / your colleagues contributions toward research about competitiveness by the Finnish industrial forest sector?
    a) Are your contributions currently sufficient for your goals / objectives in this area of research? If not, what improvements would be needed? How would those be achieved?
4) **RESEARCH FUTURES:** What do you think are the key competitiveness challenges for Finnish industrial forestry actors currently in your view? And in the next 10 years?
    a) What opportunities are there for the Faculty to address those challenges through research outputs and outreach?
5) **RESEARCH PRIORITIES:** What should be the research priorities generally within the Faculty to support a more competitive Finnish industrial forest sector? Within your field of study (indicate/define)?
    a) How might those priorities be best achieved within the next 10 years?
6) **OPEN DISCUSSION:** Please feel free to discuss any related topics that you feel are important for supporting this research.

Supplementary References

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